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Factsheet

GULLY EROSION CONTROL

(Revision to Factsheet "Gully Erosion Control "May 1985)

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Throughout Ontario, especially in areas with deep sand plains, high stream banks or long sloping valleys, extensive gully erosion problems occur. Large quantities of valuable agricultural soils are lost each year to gully erosion.

Gully erosion is an advanced stage of rill erosion where surface channels have been eroded to the point where they can not be smoothed over by normal tillage operations.

Figure 1 An active gully in a sand plain area

Often, gullies can be prevented if good land conservation measures are practiced on the farm. Good tillage and cropping practices increase the absorptive capacity of the soil resulting in less runoff and also protect the land surface from erosion. Surface and tile water should be conveyed from lands through proper waterways so as not to create potential gully problems. Buffer strips should be located at potential gully start points such as open ditches or deep depressions.

The saying "A Stitch in Time Saves Nine" is also valid for gully erosion control. Often a potential large gully problem can be solved if discovered and controlled early in its formation.

Figure 2 A gully located on clay soil. A grassed waterway shown in Figure 3 was used to solve this problem.

CAUSES OF GULLY FORMATION

(1) **Increase in flow of surface (or subsurface) water**
An increase in water flow can be due to several reasons such as improvement of drainage channels upstream, removal of water holding areas upstream (such as a swamp or bush), enlargement of the watershed or a change in tillage and cropping program in the watershed.

(2) **Decrease of soils resistance to erosion**
There are several ways that a soils resistance to erosion can be reduced such as elimination of a vegetative cover, breakdown of soil structure due to poor tillage and cropping practices, constant saturation by a trickling tile or compaction by tractor wheels.

(3) **Sloughing and mining at the bottom of the gully**
Sloughing occurs at the base of a gully due to a strong spring, a constant saturation of the area by a pond or the eroding power of a waterfall from a higher to lower elevation, e.g. cultivated field to eroded channel. As the undermining process continues, the gully head moves upstream and enlarges in width and depth.

DESIGN OF A CONTROL SYSTEM

In the design of a control system for a gully problem the following steps are to be followed.

(1) Inspect the gully to determine why the problem occurred; what possible changes have taken place to aggravate the problem? Is there a spring at the gully base?

(2) Estimate the peak flow of water entering the gully. This quantity depends on the watershed's topography, size, vegetation, soil type and water storage capacity. Technical expertise is required for this step.

(3) Measure the approximate size and slope of the gully.

After this information is obtained, a control system can be selected. There are two types of control systems available: (a) the low to medium gradient systems utilize soil linings, drop structures or a buried pipe to run the water down the gully slope; and (b) the high gradient system uses drop pipe inlets to carry the water to a satisfactory outlet.

LOW GRADIENT SYSTEMS (0-25%)

(1) Grassed Waterway

If the gully slope is small (less than 5%) and the available channel is quite wide (more than 20 feet) a grassed waterway can carry a medium to large flow of water (Figure 3). Initial establishment of the vegetation can be a problem. Maintenance practices such as fertilization and mowing of the

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vegetation as well as land management practices above the gully area to prevent sedimentation of the waterway are necessary for this control system to be successful.

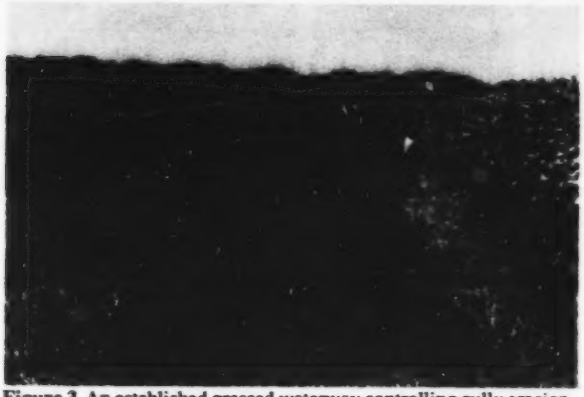

Figure 3 An established grassed waterway controlling gully erosion in a corn field

(2) Grassed Waterway With Drop Structures

If a channel slope is too steep (5-10%) for a grassed waterway, a series of drop structures can be used to reduce the effective slope of the waterway below the upper limit of 5% for a grassed waterway installation. Drop structures can either take the form of a chute spillway or a grade control structure.

(a) Chute Spillways

Chute spillways are constructed with rock riprap, interlocking or cable-connected concrete blocks or other materials and are designed to carry a concentrated flow of water down an inclined structure (Figure 4). They blend in well with grassed waterways since their shapes are similar. These structures must be underlain with a filter cloth material.

Figure 4 A chute spillway absorbs the energy of the flowing water

(b) Grade Control Structures

Grade control structures are a type of drop structure that reduces waterway grade by providing vertical drops up to 3 feet at selected locations along the channel (Figure 5). There are two main types of grade control structures used in agriculture: (a) the gabion basket type; and (b) the wood log type. These structures should always be backed with a filter cloth material to prevent soil from washing through and causing failure. For further information on grade control structures see Factsheet *Gabion Basket Drop Structures Along Waterways*.

Figure 5 Gabion basket grade control structures move water down slopes.

(3) Lined Waterway

If the channel slope is in the range of 10-25% throughout a significant portion of its length, the entire steeply sloping section could be lined with an erosion resistant material. Acceptable lining materials are rock riprap, gabion mattresses and interlocking or cable-connected concrete blocks. These structures must be underlain with a filter cloth material. An unflexible channel lining such as poured concrete does not have the ability to move with the base material shifts caused by settling, frost heaving or possible erosion. Thus, concrete is not recommended as a waterway lining.

The velocity of water exiting this structure may be excessive, causing further erosion problems downstream. A deceleration device such as large rock riprap may be required.

(4) Surface Water Inlet and Buried Tile Line

A surface water inlet such as a catch basin or perforated riser pipe connected to an underground tile line will remove runoff water from small watersheds (Figure 6). Most gully gradients are acceptable with this system; however, the recommendations regarding maximum and minimum grades in OMAF Publication 29, *Drainage Guide for Ontario* should be adhered to. A clay berm should be constructed slightly downstream of the surface inlet to pond the water and allow the surface inlet to operate at full capacity.

Figure 6 A perforated riser pipe which intercepts surface water and moves it underground.

When the topography of the land is suitable, a larger berm may be constructed that will pond water for periods up to 24 hours (Figure 7). The construction of this floodwater storage for smaller watersheds (or water and sediment control basin) results in a significantly reduced outlet tile size. Watershed areas up to 50 acres can feasibly be designed using a floodwater storage system. Proper design of this system is critical since failure could cause dramatic erosion problems.

Figure 7 A floodwater storage (water and sediment control basin) holding back water

HIGH GRADIENT SYSTEMS (greater than 25%)

When excessive gully slopes are encountered, drop pipe inlet systems provide acceptable solutions to erosion problems.

Drop pipe inlets are normally used for high drop, high gradient locations. A concentrated flow of water is carried through an enclosed pipe structure made of steel, plastic or concrete to a satisfactory outlet. Most of the components of the drop pipe inlet, if steel or plastic, can be prefabricated to reduce field construction time. A clay berm is constructed in conjunction with the drop pipe inlet to allow the runoff water to pond at the intake and force the pipe to flow at full capacity (Figure 8). The structure should be constructed similar to a dam except instead of holding water, it holds back soil. For further information on drop pipe inlets see Factsheet *Drop Inlet Spillways*.

Figure 8 A drop pipe inlet system with a high berm to allow temporary floodwater storage.

The following types of drop pipe inlets are commonly used in agriculture.

(1) Drop Pipe Structure

This structure consists of a vertical pipe fabricated to a horizontal pipe which is installed at approximately 1% grade to the outlet (Figure 9). Although this type of drop pipe can handle elevation differences up to 10 feet it is preferable to limit the drop height to 5 feet for safety construction reasons.

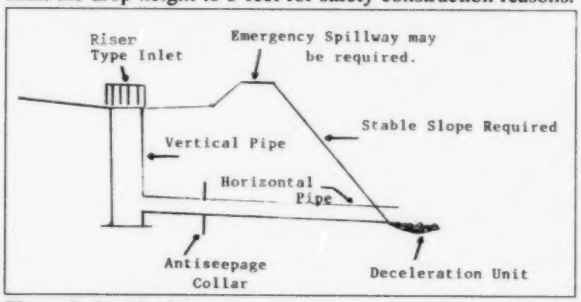

Figure 9 Sketch of drop pipe structure

(2) High-Drop Inlet Structure

The high-drop inlet is similar to the drop pipe structure except that the vertical pipe is about 5 feet high and the horizontal pipe follows the surface of the gully once it intercepts with the gully face (Figure 10). This structure is used for steep gully drops greater than 5 feet in height.

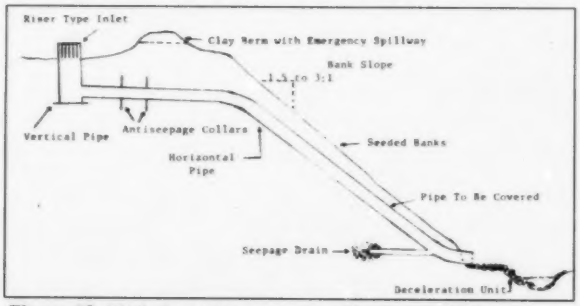

Figure 10 High-drop inlet structure with seepage drain

(3) Sloped Pipe Structure

The sloped pipe structure consists of one component, a sloped pipe (Figure 11). This type of structure may be used when drops exceed 5 feet.

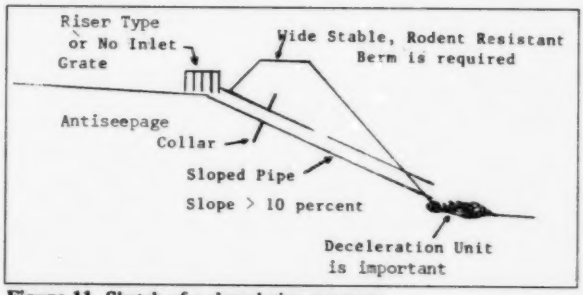

Figure 11 Sketch of a sloped pipe structure

(4) Surface Water Inlet and Buried Tile Line

A perforated riser pipe or catch basin in conjunction with a buried tile line can be used to convey runoff water from small watersheds down steep slopes. This inlet system can be used for most gully drop heights provided that the maximum grade

recommendations for the tile line as outlined in OMAF Publication 29, *Drainage Guide for Ontario* are followed.

Figure 12 A perforated riser pipe and tile line being installed

The different drop pipe inlets have flow capacities that are dependent upon the structure sizes. More than one drop pipe inlet system may be used at one gully site to carry the design flow.

To increase the effective capacity of the drop pipe inlet system a floodwater storage is often used. This storage will fill up with water during peak flow periods and empty after the peak flow is over. If flood storage is used, it is important to have an emergency spillway to convey water down the berm if expected flow rates are exceeded; otherwise, failure of the berm may occur.

CONSTRUCTION OF THE CONTROL SYSTEM

Proper installation of the drop pipe inlet is important to ensure that a future failure does not happen. Antiseepage collars should be installed on all horizontal pipes to prevent water from channelling along the outside of the pipe. A well constructed clay berm that has been adequately compacted around the pipes is imperative.

If groundwater seepage appears to be contributing to the problem a seepage drain (Figure 10) should be constructed to intercept the water flow from the spring. This seepage drain utilizes a filtered tile or rock bed to drain out the water without moving the soil.

The system should be constructed at a time when peak flow is not expected. The vegetative cover must have time to become established in the channel. A good set of plans and a well thought out sequence is very necessary.

MAINTENANCE OF THE SYSTEM

Any erosion control system needs regular attention to check and repair weak areas before failure occurs. A checklist should be followed as below:

(1) Any bare or eroded area should be repaired immediately.

(2) Obstructions or potential obstructions in the flow area should be removed.

(3) Any settling or shifting should be repaired.

(4) All grassed areas should be mowed twice per year.

(5) The inlet for the control system should be cleared of snow and ice before the spring peak flows.

(6) All berms should be checked regularly for signs of failure and remedial measures taken.

ASSISTANCE

Technical assistance is available from the Agricultural Engineer at the local office of the Ontario Ministry of Agriculture and Food. The Conservation Authorities may offer both technical advice and construction supervision in certain areas of the Province.

For the large gully projects that have a high capital cost and high risk involved it is recommended that a Consulting Engineer be hired for design and supervision of the project.

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